IS LIFE TRULY PRICELESS?

INTRODUCTION

How much should society spend to keep toxic wastes from killing people? Would you drink a glass of water containing dioxin if there was a one-in-a-million chance of dying from it? How much better would you feel if the chance was only one in a billion? Is *any* level of risk "acceptable"? Should society protect people from pollution "at any cost"? The answers to these questions depend upon how society values human lives. In this lesson students discover the sometimes surprising result that society in general does not place an infinite value on a life (whether it should do so or not).

ECONOMIC CONCEPTS

Value

ENVIRONMENTAL CONCEPTS

Statistical Life
Dioxin
Probability of Death

OBJECTIVES

- Explain the difference between a specific person's life and a statistical life.
- Describe "a reduction in the probability of death" as a product which has value and requires resources to produce.
- Calculate the value of a statistical life based on observation of the choices society makes.

LESSON DESCRIPTION

The lesson introduces various ways to place a value on a human life. The economic approach involves thinking of "a reduction in the probability of death" (or "an increase in life-saving measures") as a product, like other products, which has value and requires resources to produce. The quantity of resources to be devoted to producing this product may be decided by weighing the value of the product against the costs of producing it — as we do in the case of other products. Based on such an assessment, students calculate the value of a statistical life and examine values actually used by government agencies.

TIME REQUIRED

One class period

MATERIALS

Newspaper/magazine article describing a recent rescue effort
One copy for each student of Activities 1, 2, 3, and 4
Transparencies of Activities 1 and 4

PROCEDURE

What is a Human Life Worth?

1. Ask: What is a human life worth? Discuss responses as follows:

   Accept all answers. Answers will vary, and some students will say it is not possible (or even ethical) to place a value on a human life — that is, human life is "priceless" or of infinite value.

2. Then ask: How could people in our society measure the value of a human life? Show a transparency of Activity 1, or distribute copies of it. This activity lists some common approaches to the task of measuring the value of a life. Ask students to discuss, briefly, the merits of these alternatives and to suggest other possibilities. Tell the class that economists actually do not use any of these methods to determine the value of a life to a society. This leaves the

original question unanswered and also raises a new one: Why isn't life "priceless"?

Saving a Specific Person's Life

3. Present a newspaper or magazine article (which you have found and brought to class) describing some rescue effort (for example: finding miners after a cave-in, flying a donor organ across country, digging through building rubble for possible earthquake survivors, tunneling down to save a toddler who has fallen into an abandoned well, etc.). Ask students to describe the amount of resources (human, capital, natural) used in these efforts.

    Since these resources were diverted from other uses, they represent the cost of the rescue effort.

    Ask the class: Is the benefit of saving these lives worth the cost? Discuss responses:

    Most students will respond that it is (i.e., the goods and services that must be forgone when resources are diverted are less valuable than saving a specific person's life). In other words, the life of a specific person in certain danger has very large if not infinite value. In this case, a life is likely to be "priceless" to society.

4. Continue the discussion: What if these resources could save even more lives if they were used in another way? Economics tells us that resources are scarce. For example, suppose a single emergency crew (the resource) could respond to a car accident or to a burning building, but not both. Suppose lives are at stake in both cases. Ask: To which scene should the emergency crew go? Discuss responses:

    Answers will vary. It is important to emphasize that scarcity forces a choice; sometimes lives, even if they have an infinite value, may have to be given up.

Probability of Death

5. Now ask the class to consider how a life is valued when it isn't known for certain whose life may be in danger. For example, many pollutants in our air and water pose a health risk of some kind. Some people will inevitably be adversely affected, and some will die. But we don't know who or when. Distribute a copy of Activity 2 to each student. Explain its contents as necessary.

    At one end of the scale, the probability of death is 1.00 (that is, death is certain to happen), while at the other end the probability is zero (death is impossible). Note that the "probability of death" may be defined as the number of people who are expected to die as a result of engaging in some activity divided by the total number of people who engage in that activity.

6. Ask students working in groups of three to four to discuss where each of the activities listed might lie along the spectrum. Allow 10 minutes and then discuss their decisions in class. After a brief discussion, compare the students' rankings with the following estimates. (Most of the estimates are adapted from *What Are The Chances?*, by Bernard Siskin, Jerome Staller, and David Rorvik (Crown Publishers, Inc. 1989). Some estimates have not been calculated.)

    a. flying in a commercial airplane: .0000003 (0.3 chances in a million)
    b. driving/riding in a car: .0002 (200 chances in a million)

c. getting struck by lightning: .000001 (1 chance in a million)
d. smoking cigarettes: .00625 (6250 chances in a million)
e. working as a lumberjack: .001 (1000 chances in a million)
f. working as a police officer: .0004 (400 chances in a million)
g. playing “Russian roulette” with a six-shooter: .167 (166,667 chances in a million)
h. living in Southern California during the next 50 years: .0005 (500 chances in a million, reflects the probability of dying as a result of an earthquake measuring at least 8 on the Richter scale)
i. getting AIDS from a blood transfusion: .00001 (10 chances in a million)
j. staying at a motel: .0000004 (0.4 chances in a million, reflects the probability of dying in a motel fire)
k. having a baby: .00005 (50 chances in a million)
l. taking a prescription drug: .0005 (500 chances in a million, reflects the probability of dying from an adverse reaction)
m. living in a home with radon: .000005 (5 chances in a million)
n. falling down: .000002 (2 chances in a million)
o. dying from a heart attack: .60 (600,000 chances in a million; this is not the probability of having a heart attack, but the probability of dying if you do have a heart attack)
p. drinking water directly from a nearby river: ?
q. breathing air in your area: ?
r. eating vegetables sprayed with some herbicide or pesticide: ?
s. living near a nuclear power plant: ?

Comparing some of these values should lead to a lively discussion. (It might be noted that the perceived risk people associate with different activities often differs greatly from the actual level of risk.)

Note that items p-s relate to risk associated with the way we use the environment. Ask the students: How low should these risks be? Discuss responses.

7. Distribute a copy of Activity 3 and ask the students to complete it, again working in groups of three to four. Allow 10 minutes and then discuss their responses as follows:
   a. No. Neither of these activities has a zero probability of death. There is a risk of being involved in an accident (a drunk driver could weave into your lane unexpectedly) and a risk of lung disease from inhaling air pollutants. In fact, no activity is entirely risk-free. You could always be struck by a falling meteorite!
   b. If you value your life at all, yes. People express this value (willingness and ability to pay for risk reduction) by paying more for cars with better safety features and buying other products such as smoke detectors and air and water filters. These actions imply that reducing the probability of death is a valuable product.
   c. For highway driving: better road construction methods (wider lanes, fewer blind curves, more guardrails), better driver education, cars with additional safety equipment, and driving at slower speeds. For air pollution: less production of products (to reduce the amount of air pollution caused in the first place), increased

use of pollution control devices, restricted use of cars and trucks, and emissions released at timed intervals so the environment doesn't have to assimilate so much at one time.

d. For highway driving: most of these require that resources be diverted from other uses (so the value of these other uses is given up); for driving at slower speeds the costs are the value of time spent in other activities that must be given up and the increased cost of transporting resources and products. For air pollution: lost value of products, resources required for pollution control, lost convenience (see other costs in Lesson 4).

e. Students should remember that this goal is probably not even possible. For highway driving one could imagine designing cars resembling tanks, enforcing 2 mph speed limits, building "clover-leafs" at all intersections so roads do not cross each other, and building domed highways to prevent bad weather conditions — all in an effort to reduce highway fatalities to zero. But, would it be worth the cost? Similarly for air pollution one could imagine ceasing all use of energy and other natural resources, or collecting 100% of all wastes and sending them into outer space. Again, would it be worth the cost?

f. It depends on the value of additional reductions in the probability of death in each activity, and the cost of producing these reductions. If the value is high and the costs low, the probability of death should be reduced quite a bit. If the cost is high and the value low, it shouldn't be reduced as much. Thus, the "acceptable level of risk" (the probability of death) in different activities (such as driving and breathing air pollutants) may be different (such as one in a million versus one in a billion).

The Value of a Statistical Life

8. If we know how much people value a reduction in the probability of death associated with a given activity, we can use that value to determine the value of a statistical life. Pose the following problem for students, working again in groups of three or four:

   There are one million people who fish in a given region. Suppose each of them is willing and able to pay \$5 for a new water treatment process which will reduce the probability of death caused by eating fish taken from the region's waterways from .00011 (11 in 100,000) to .00010 (10 in 100,000). What does this suggest about how much a life saved by this process is worth?

   This analysis may be difficult for some students, but it underscores the link between the probability of death and the implied value of a statistical life. To solve the problem, students first should determine how many lives will be saved; then they should divide that number by the total amount everyone is willing and able to pay for this change. For example: without the process, 110 lives would be lost (.00011 x 1 million), while with the process only 100 would be lost (.00010 x 1 million). Thus, the new process is expected

to save 10 lives. Since each person is willing and able to pay $5 for this reduction, the total value is $5 million ($5 x 1 million). So, 10 lives saved are worth $5 million, or each life is worth $500,000. Note that these are statistical lives — it is not known for certain which 10 of the 1 million users will have their lives saved.

9. The implied value of a statistical life can also be determined by considering the costs of reducing the probability of death. Ask students to consider the following problem: Suppose the government begins requiring all incinerators to install a particular pollution-control device. The total cost of compliance is estimated to be $500 million. It is expected to reduce the probability of death from air pollution across the country (population 250 million) from .000002 (2 in 100,000) to .000001 (1 in 100,000). What is the implied value of a life if society decides this policy is worthwhile?

   The number of lives lost drops from 500 (.000002 x 250 million) to 250 (.000001 x 250 million). So, 250 lives are saved at a cost of $500 million. Thus, each life must be worth at least $2 million ($500 million/250).

10. Show a transparency of Activity 4. This activity shows the implied value of a statistical life based on decisions such as the one above, made by various government agencies. Note that the value of a statistical life varies from around $1 million to as high as $8 million, depending on the nature of the activity involved.

EXTENSION ACTIVITIES

Government/Law

11. When someone loses his or her life because of someone else's negligence, those affected can sue to recover damages imposed on them (such as loss of income, pain and suffering, medical/funeral expenses, etc.). Invite a forensic economist or an attorney who specializes in this area speak to the class about how the amount of damages is determined. Ask the class: Does this amount reflect the true value of the person's life? Discuss responses.

    Most students will respond that no amount of money could replace the life of a loved one (i.e., the life of a loved one is infinitely valued), and so this amount is too low. Note that this is a case which involves attempting to place a value on a specific person's life. This is based on the "productivity value" listed in Activity 1.

Science

12. Assign students to research the elemental make-up (percent of each element) of the human body. They should use these percentages to determine the weight of each element in their own bodies (students should use their own weights). Finally, they should determine the total value of these elements as described in (a) in Activity 1. Ask: What does this measure of value say about dieting?

    Dieting will make you less valuable! This helps students see the absurdity of this measure.

13. With reference to (b) in Activity 1, assign students to research exactly what body parts can currently be "reused" (for example, parts of the

eye, lungs, livers, kidneys, hearts, bone marrow, others?).

Economics

14. Add the following to the discussion above: To estimate people's willingness and ability to pay for a reduction in the probability of death, economists consider the wage differences between similar jobs with different levels of risk. For example, if two similar jobs had probabilities of death of .00011 and .00010 respectively, one would expect the first to pay workers a slightly higher wage to cover the additional risk. If this difference was $5 per year, then it could be concluded that the reduction in probability of death is worth $5.

ACTIVITY 1

WHAT IS A HUMAN LIFE WORTH? SOME ALTERNATIVE "ECONOMIC" MEASURES

a. VALUE OF THE ELEMENTS
Break down a human body into its elemental parts: oxygen, hydrogen, carbon, magnesium, iron, zinc, and others. Determine the weight of each for an average person. Multiply the weight of each by the current market price of the element. Sum these values to get the total worth.

b. VALUE OF THE WHOLE IS THE SUM OF ITS PARTS
Many parts of the body are "in demand" by others as transplants (blood, heart, lungs, kidneys, liver, etc.). People's willingness and ability to pay for these individual parts could be summed to get the total worth.

c. A HUMAN LIFE IS "PRICELESS"
No monetary value can possibly be placed on a human life. It has an infinite value.

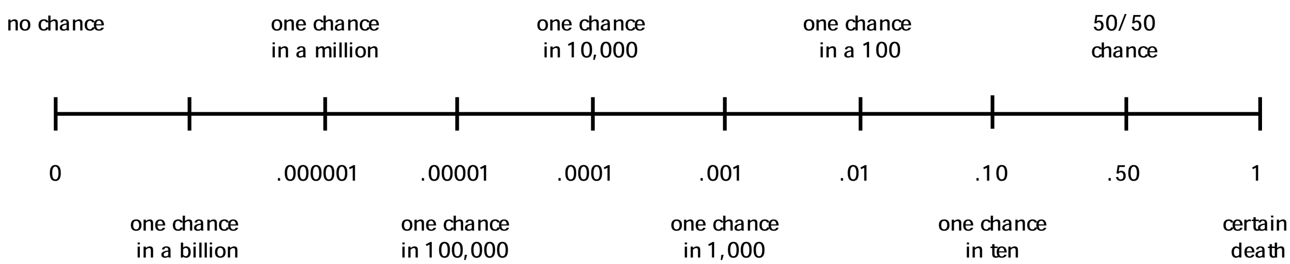
d. PRODUCTIVITY VALUE
A life is valued according to the production society would lose from having one less human resource. This loss can be measured by the present value of one's expected stream of future earnings.

e. WILLINGNESS AND ABILITY TO PAY
Determine what people are willing and able to pay to avoid a certain death (note that this is not infinite, since people's "ability" to pay is limited).

ACTIVITY 2

THE PROBABILITY OF DYING FROM SELECTED ACTIVITIES

Probability of Death



The probability of death from engaging in a given activity may be defined as the number of people who are expected to die as a result of engaging in that activity divided by the total number of people who engage in it.

Discuss the probability of death from engaging in the following activities. Where would each activity lie along the line above? Which are most dangerous? Which are the safest?

a. flying in a commercial airplane
b. driving/riding in a car
c. getting struck by lightning
d. smoking cigarettes
e. working as a lumberjack
f. working as a police officer
g. playing “Russian roulette” with a six-shooter
h. living in Southern California during the next 50 years
i. getting AIDS from a blood transfusion
j. staying at a motel
k. having a baby
l. taking a prescription drug
m. living in a home with radon
n. falling down
o. having a heart attack
p. drinking water directly from a nearby river
q. breathing air in Los Angeles
r. eating vegetables sprayed with some herbicide or pesticide
s. living near a nuclear power plant

ACTIVITY 3

THE PRODUCT: A REDUCTION IN THE PROBABILITY OF DEATH

Consider two things you are likely to do in your lifetime: (1) drive on highways and (2) breathe polluted air in a large city. Answer the following questions for each of these activities:

a. Is either of these activities 100% safe (that is, the probability that you would die as a result of engaging in the activity is zero)?

b. Would you be better off if these activities were made safer (that is, if the probability of dying from engaging in them was reduced)?

c. Suggest some ways to make these activities safer.

d. What are the costs associated with these suggestions (that is, what exactly must be given up)?

e. Do you think society's goal for these activities should be to make them 100% safe?

f. If society's goal is to maximize the net value (benefits minus costs) it gets from each product, how much of the product (a reduction in the probability of death) should be produced in each of these cases?

ACTIVITY 4

THE VALUE OF A STATISTICAL LIFE

Department of Agriculture: $1.1 million

Department of Transportation: $1.0 - $1.5 million

Consumer Product Safety Commission: $1.5 - $2.0 million

Occupational Safety and Health Administration: $2 - $3.5 million

Nuclear Regulatory Commission: $5 million

Environmental Protection Agency: $1.6 - $8 million

Source: Ted Miller, Urban Institute (1990).